Can a Random Forest Model predict the presence of Heart Disease?

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Outline

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4. Results
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6. Conclusion

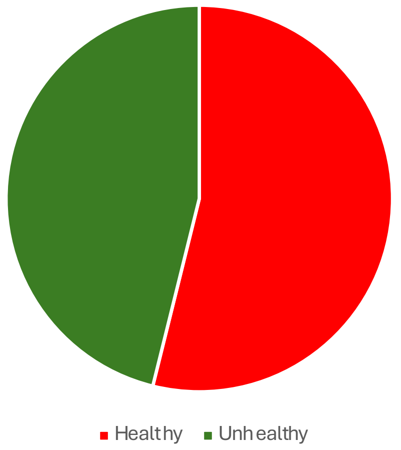
Data set description

- Data set from Cleveland Clinic in Cleveland, Ohio from 1989
  - Contains clinical data about patients with and without heart disease (coronary artery disease)
  - Often used by ML researchers
- First used in: “International application of a new probability algorithm for the diagnosis of coronary artery disease” by Robert Detrano et al. in 1989
  - Goal: testing probability algorithms to predict heart disease
  - Findings: prediction works in general good, but several algorithms overpredicted the probability of heart disease

Outcome variable

Variable Name	Description	Variable Type	Values
hd	diagnosis of heart disease	binary	0: no 1: yes

- 297 observations
- 13 features (explanatory variables)
- Balanced sample:
    - Healthy: 160 (54%)
    - Unhealthy: 137 (46 %)



Explanatory variables

Variable Name	Description	Variable Type	Values
age	age in years	continues values	[29, 77]
sex	gender	binary	0: female 1: male
cp	chest pain type	ordered factor	1: typical angina 2: atypical angina 3: non-anginal pain 4: asymptomatic
trestbps	resting blood pressure (in mm Hg on admission to the hospital)	continues values	[94, 200]
chol	serum cholestoral in mg/dl	continues values	[126, 564]
fbs	fasting blood sugar > 120 mg/dl	binary	0: no 1: yes
thalach	maximum heart rate achieved	continues values	[71, 202]
exang	exercise induced angina	binary	0: no 1: yes

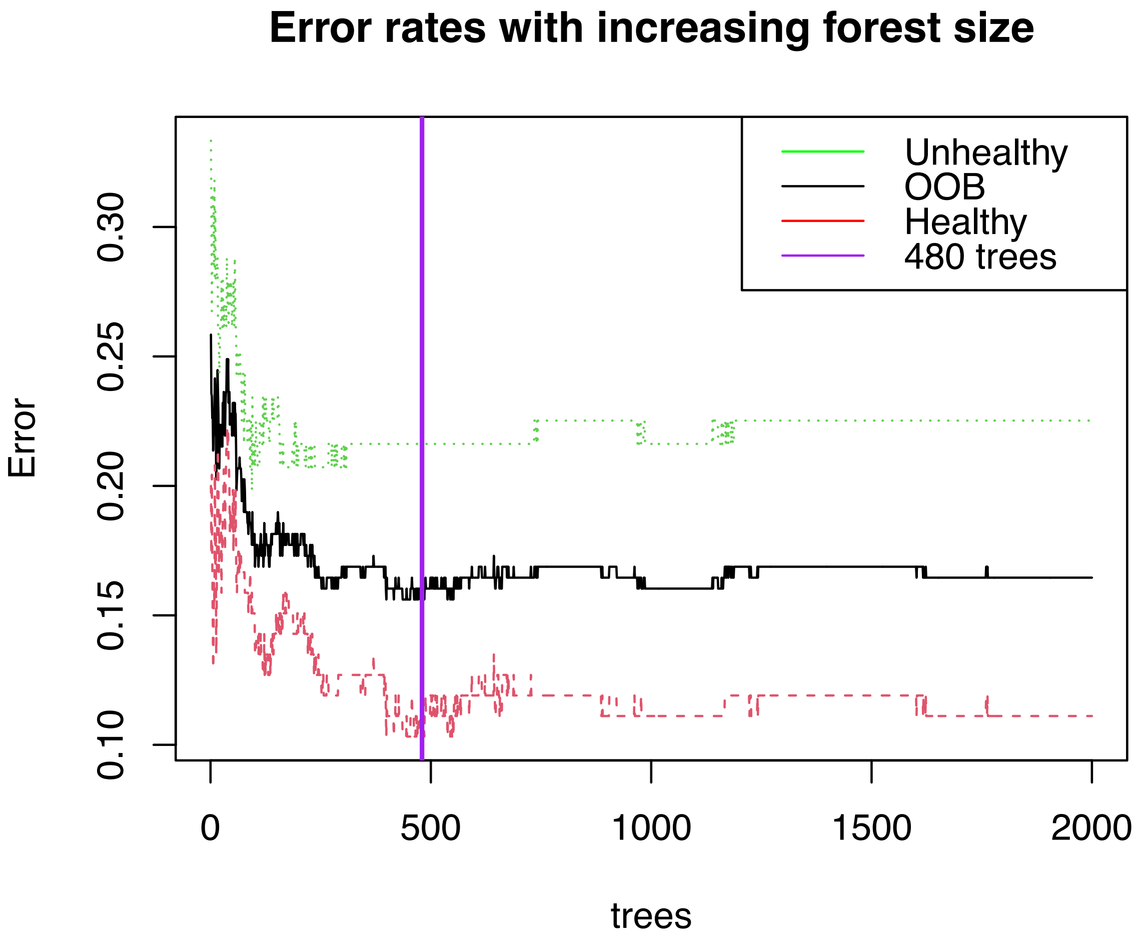
Explanatory variables

Variable Name	Description	Variable Type	Values
restecg	resting electrocardiographic results	ordered factor	1: normal 2: having ST-T wave abnormality (T wave inversions and/or ST elevation or depression of > 0.05 mV) 3: showing probable or definite left ventricular hypertrophy by Estes' criteria
oldpeak	ST depression induced by exercise relative to rest	continues values	[0.0, 6.2]
slope	the slope of the peak exercise ST segment	ordered factor	1: upsloping 2: flat 3: downsloping
ca	number of major vessels colored by flourosopy	ordered factor	{0, 1, 2, 3}
thal	thalium heart scan	ordered factor	1: normal 2: reversable 3: fixed defect

Methodology

- Using Random Forest as classifier
- Set seed for every process that includes randomness
    - ➢Reproducibility
- Cross-Validation for comparison with other methods
    - ➢Train dataset: 80% of observations (237)
    - ➢Test dataset: 20% of observations (60)
- Choice of number of trees based on error plot
- Choice of number of features to consider in each tree based on optimal OOB error

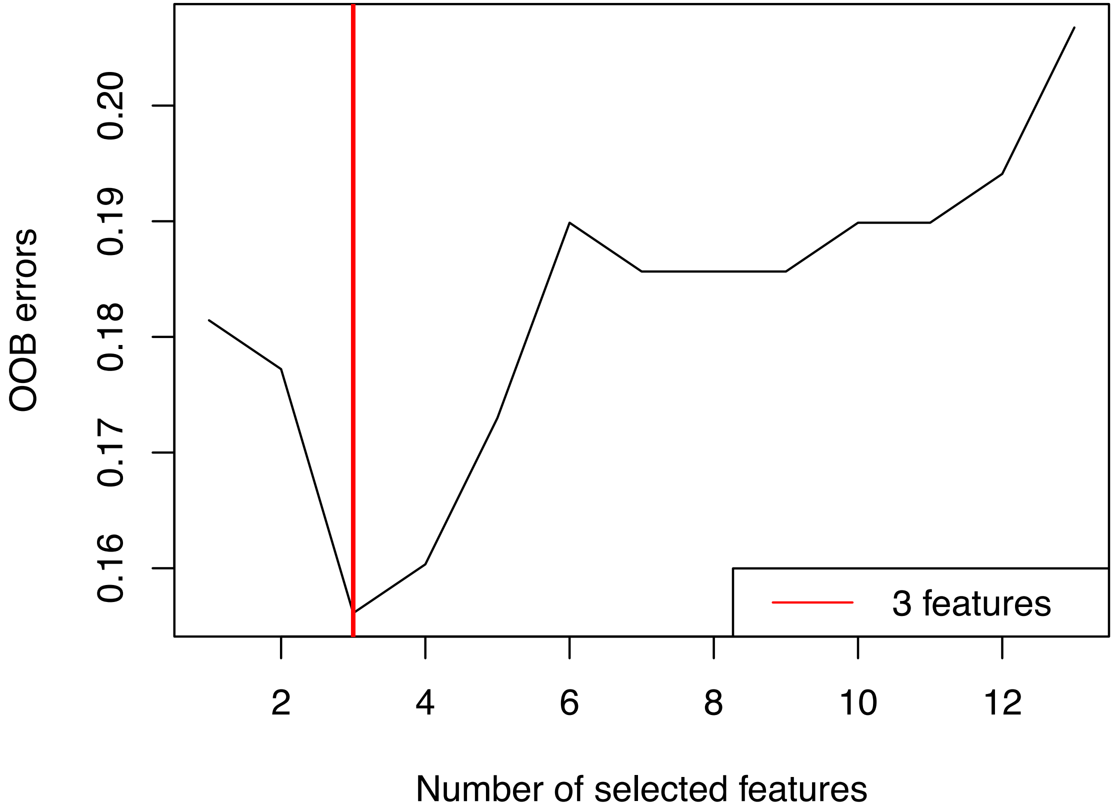
Choice of number of trees



- All error rates seem to stabilize with around 400 trees
- Default setting in R: 500

➢480 trees seems to be a good choice (smallest error)

Choice of number of features

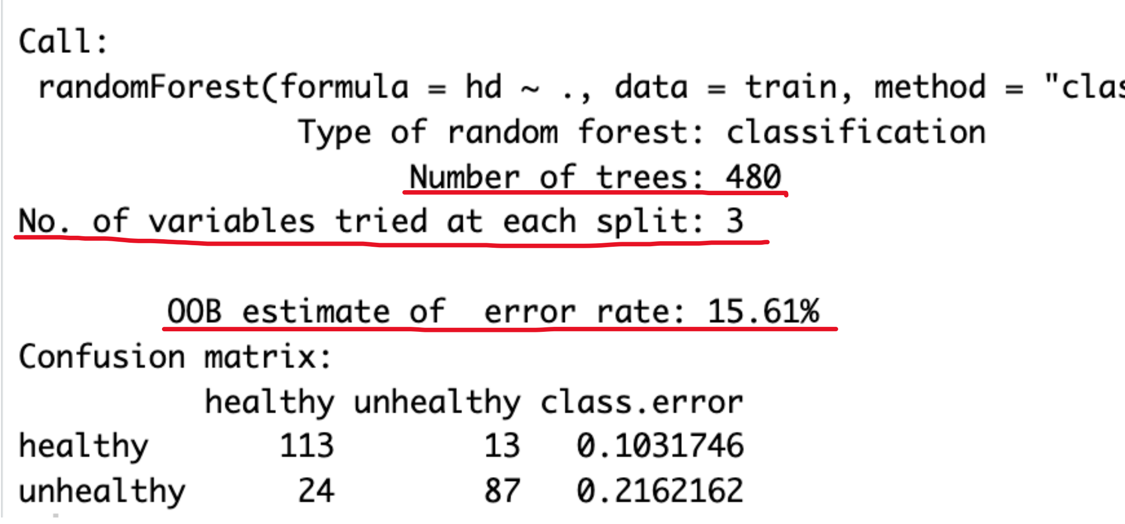


- Trying 1 to 13 with for loop

➢ choosing option with lowest OOB error

- Choosing 3 values for model
  - Minimal OOB error
  - Close to rule of thumb: $\sqrt{features} = 3.6$

Final forest and results



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Call:
 randomForest(formula = hd ~ ., data = train, method = "class",      ntree = 480, mtry = 3)
               Type of random forest: classification
                     Number of trees: 480
No. of variables tried at each split: 3

        OOB estimate of  error rate: 15.61%
Confusion matrix:
          healthy unhealthy class.error
healthy       113        13   0.1031746
unhealthy      24        87   0.2162162
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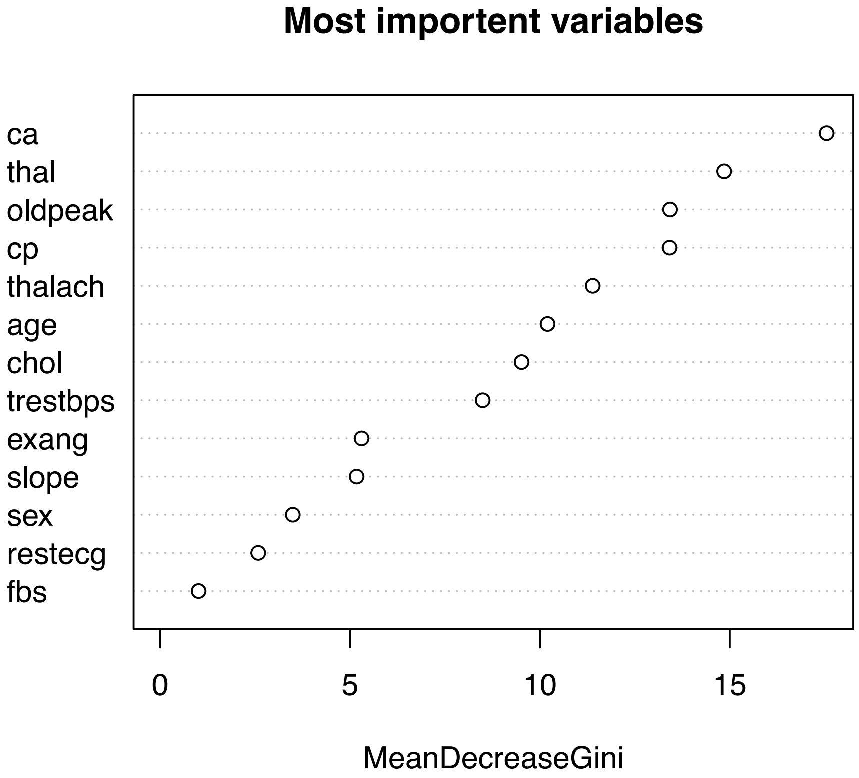


In train data:

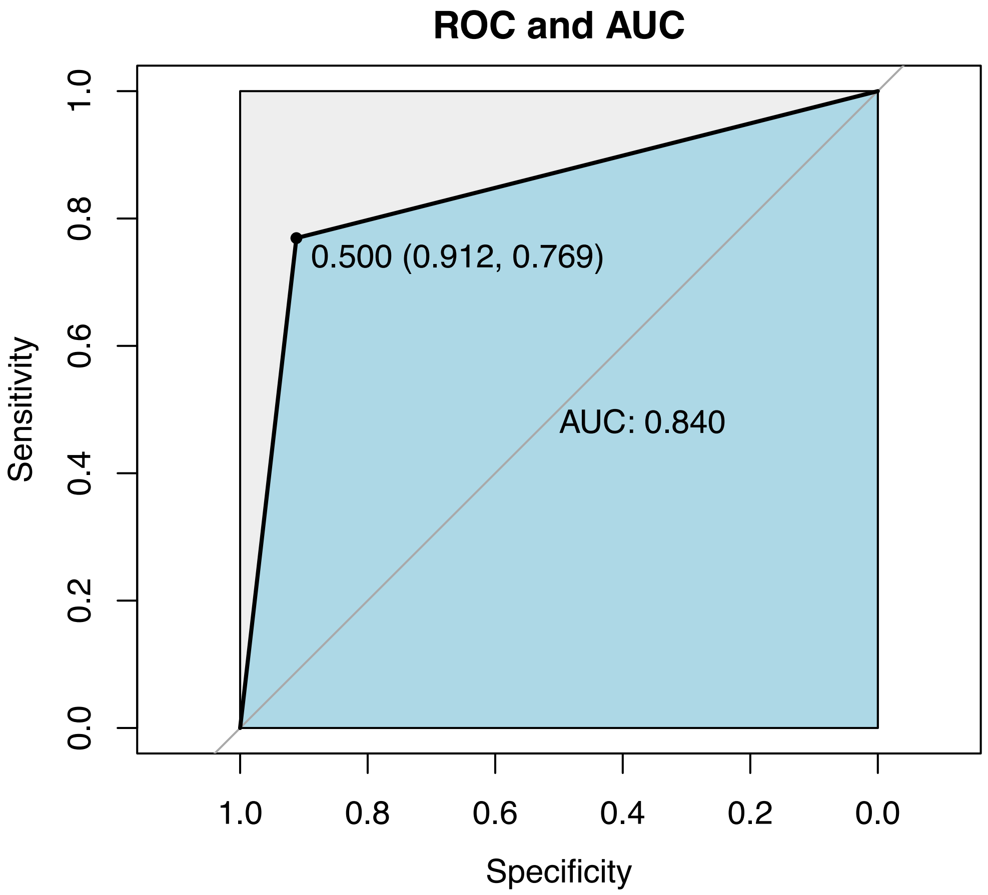
- $RP \approx 85\%$
- $TNR \approx 90\%$
- $TPR \approx 78\%$

Predictions with test data

Test data	**Predicted**	
Observed	Healthy	Unhealthy
Healthy	31	3
Unhealthy	6	20

In test data:

- $RPR \approx 85\%$
- $TNR \approx 91\%$
- $TPR \approx 77\%$



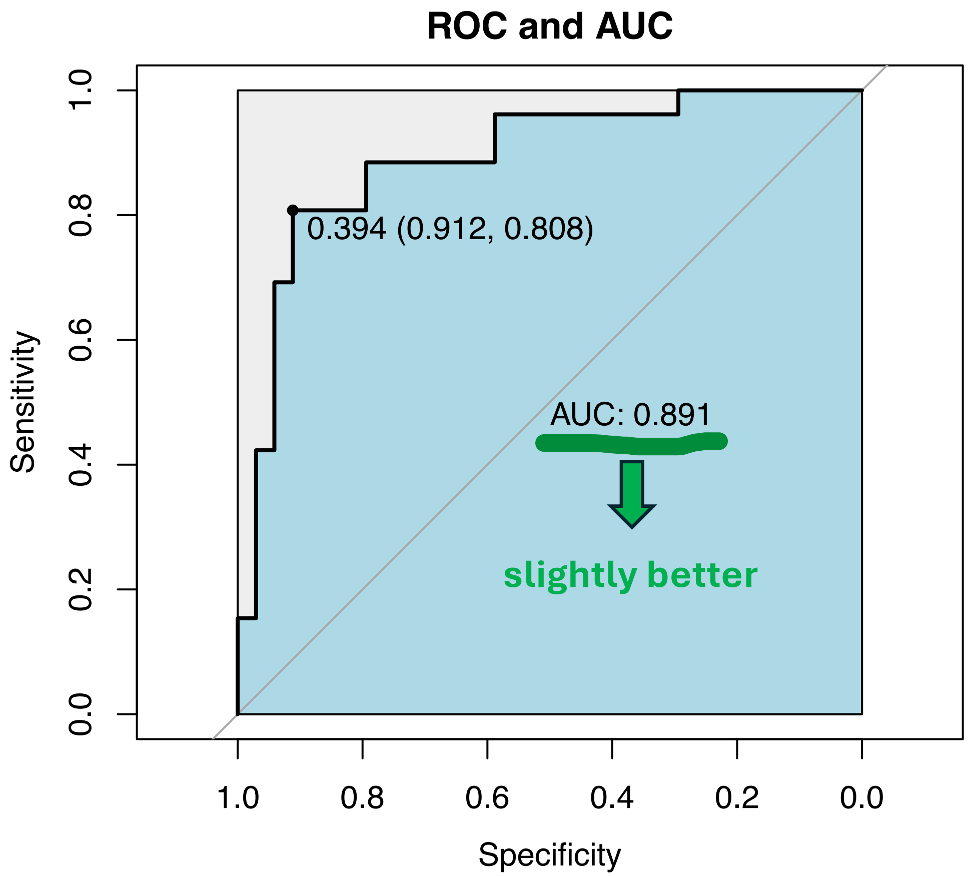
Comparing results with two other classification models

Logistic Regression prediction results

Test data	Predicted	
Observed	Healthy	Unhealthy
Healthy	31	3
Unhealthy	5	21

In test data:

- $RPR \approx 87\%$ → slightly better
- $TNR \approx 91\%$
- $TPR \approx 81\%$ → slightly better

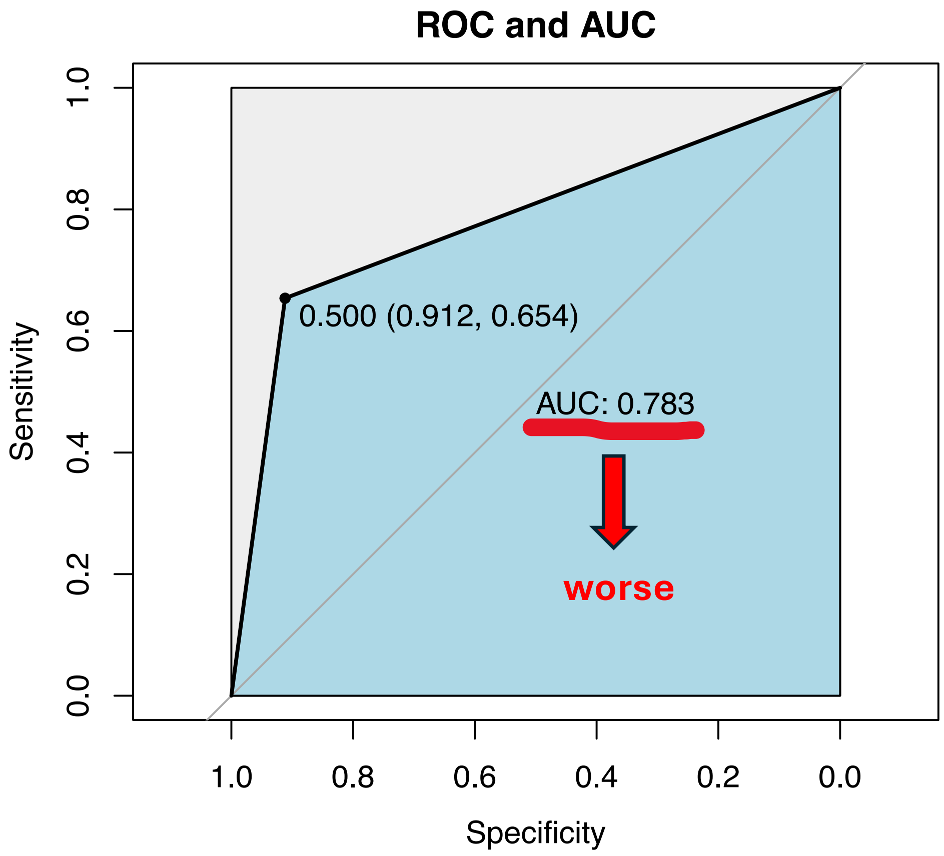


Decision Tree prediction results

Test data	Predicted	
Observed	Healthy	Unhealthy
Healthy	31	3
Unhealthy	9	17

In test data:

- $RPR \approx 80\%$ → worse
- $TNR \approx 91\%$
- $TPR \approx 65\%$ → worse



Conclusion

- Prediction of heart disease based on medical measurement with random forest possible
- Logistic Regression slightly better in that case (higher TPR)
  - ➢Question: Logistic Regression in general better for that problem?
    - ➢Only slight difference, so probably not
- Decision tree worse in that case (lower TPR)

❖Restrictions of analysis:

- Small data set
  - Random Forest tends to work better with more observations

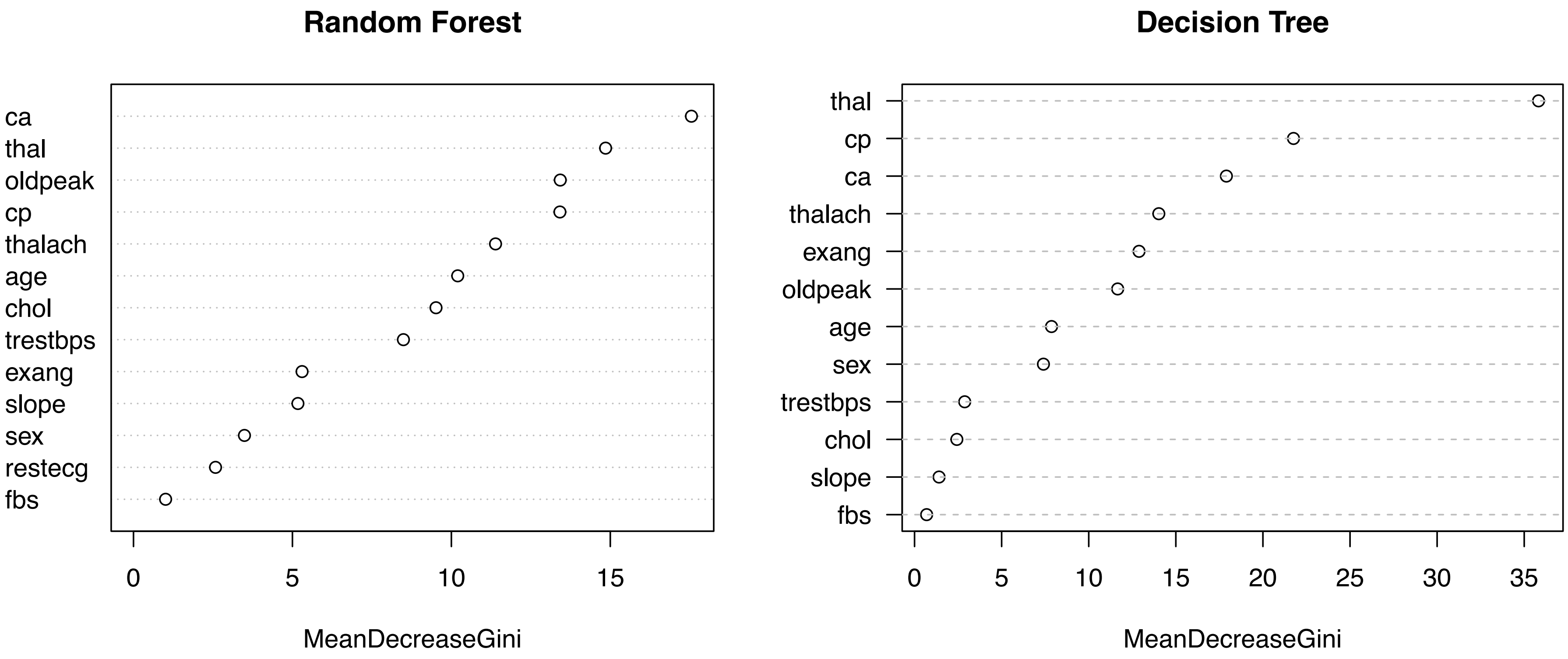
Sources

- Detrano R, Janosi A, Steinbrunn W, Pfisterer M, Schmid JJ, Sandhu S, Guppy KH, Lee S, Froelicher V. International application of a new probability algorithm for the diagnosis of coronary artery disease. Am J Cardiol. 1989 Aug 1;64(5):304-10. doi: 10.1016/0002-9149(89)90524-9. PMID: 2756873.
- Janosi,Andras, Steinbrunn,William, Pfisterer,Matthias, and Detrano,Robert. (1988). Heart Disease. UCI Machine Learning Repository. https://doi.org/10.24432/C52P4X.
- Direct link to data set: http://archive.ics.uci.edu/ml/machine-learning-databases/heart-disease/processed.cleveland.data

Thank you for listening!

Appendix

Comparing variable importance: Tree and Forest


Random Forest
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MeanDecreaseGini
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